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Phase measurement ambiguity resolution in time transfer by meteor burst channel

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Abstract

A technique used in meteor synchronization equipment constructed in Kazan State University includes transmission of time marks on several carrier frequencies. Time shift between stations is calculated on secondary station by getting the differences between phases of signal carrier waves corresponding to phases of imaginary differential frequencies and resolving their ambiguity. Phase ambiguity resolution procedure goes from lowest to highest differential frequencies at each step increasing precision of the resulting measurement. The final step in the ambiguity resolution procedureresolving ambiguity of carrier frequency phase is the hardest step requiring filtration of measurements, because for technical reasons the ratio of errors is the highest here. The reference for carrier frequency phase ambiguity resolution is unambiguous maximal differential frequency phase. Real-time filtration of unambiguous measurements can be performed in various ways. In the simplest case the unknown period of carrier frequency is chosen by current Kalmans estimate. This is not always possible because due to short-term instability of frequency standards Kalmans estimate error does not necessarily reach given threshold for reliable ambiguity resolution, even on long filtration intervals. One way to deal with that is to accept whatever Kalmans estimate value is available right away and check if the resolution has been correct later, when more precise smoothing estimate becomes available. This approach is natural in meteor burst communication where automated repeat request is widely used. Other promising approach is to resolve first the ambiguity of one or more of the previous measurements where smoothing estimate is available. Thus ambiguity of measurements with better estimates gets resolved first and, if possible, it makes estimate error for later measurements small enough for reliable resolution. Second method uses history more efficiently making first resolution decisionby estimate with lower error. On the other hand actual errors of real-time ambiguity resolution in that case are hard to analyze because possible resolution errors on each step affect the estimates by which following decisions are made.This paper shows the possibilities of real-time unambiguous time transfer on every available meteor with errors corresponding to those of single carrier frequency phase measurement (fractions of nanosecond on the average).

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